

**Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's
2019-2021 SC GIP Summary
Docket No. ND-2020-28-E**

South Carolina Grid Improvement Plan

Duke Energy Carolinas, LLC's ("DEC") and Duke Energy Progress, LLC's ("DEP" and, together with DEC, the "Companies") Grid Improvement Plan ("GIP") focuses on better serving our customers, delivering reliable and resilient service to all communities that we serve and preparing the grid for a cleaner energy future. The Companies are improving the grid to avoid outages and restore power faster than ever. We're also strengthening the electric grid to make it more resistant to outages from severe weather, and making the grid more secure, to protect against the growing threat of cyber and physical attacks. And we are transforming the grid to enable cleaner energy options and a lower-carbon future. Distributed energy resources ("DER") are important to our customers, and we believe growing these resources is an essential step towards building a cleaner energy future for our state. The grid improvements we are making help support the sustainable growth of new technologies like battery storage. Ultimately, these improvements will give customers more options and control to save energy and money.

On August 12, 2020, by Order 2020-533 in Docket No. 2019-381-E, the Commission approved DEC's and DEP's joint request to establish an informational docket for review and consideration of its Grid Improvement Plan ("GIP"). As a result of that Order, on August 14, 2020, the Commission opened Docket No. ND-2020-28-E. The Companies have filed annual status reports and corresponding virtual forum presentation materials in the above-referenced NDI docket. These reports have shown how the Companies are performing in terms of program costs and units compared to its targets.

The cumulative capital expenditures through December 31, 2021, on GIP investments incurred from 2019-2021 are approximately \$272 million in DEC and approximately \$110 million in DEP. The amount spent per GIP program is included in the Annual Status Report within this filing and summarized in Table 1. These cumulative actual capital expenditures are less than the planned expenditures for 2019-2021 by approximately 11 percent. The work completed to date has been done, overall, at a cost that is on track with planned program costs. The Distributed System Demand Response, Distributed Energy Resources ("DER") Dispatch Tool and Power Electronics for Volt/Var projects were delayed due to external factors, technical challenges and material availability. Many programs had notable key accomplishments and associated customer benefits through December 31, 2021 as outlined further in this summary. To date, the GIP programs have delivered significant customer benefits and those benefits will continue to increase as the GIP is further deployed.

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Table 1: SC GIP Programs – Planned and Actual Capital Expenditures

GIP Programs (\$ in millions)	Planned 2019-2021	Actuals 2019-2021
Self-Optimizing Grid	\$96.5	\$82.8
Distribution Transformer Retrofit	23.0	24.6
Integrated Volt/VAR Control	43.6	29.5
Distributed System Demand Response	2.0	0.0
Transmission Hardening & Resiliency	31.2	18.5
Transmission Bank Replacement	10.0	9.4
Transmission System Intelligence	21.8	15.8
Oil Breaker Replacement	7.6	17.9
Targeted Undergrounding	27.5	32.8
Long Duration Interruptions	22.8	31.0
Enterprise Communications	41.0	38.3
Distribution Automation	25.5	36.5
Enterprise Applications	7.5	3.9
Integrated System Operations Planning	6.3	1.7
DER Dispatch Enterprise Tool	3.8	0.1
Power Electronics for Volt/Var	1.8	0.6
Physical and Cyber Security - Transmission	44.9	35.4
Physical and Cyber Security - Distribution	10.0	2.8
<i>Total</i>	\$426.9	\$381.5

Key Accomplishments through December 31, 2021

Self-Optimizing Grid (“SOG”) – This program redesigns key portions of the distribution grid into a smart-thinking, self-healing grid with the ability to automatically detect power outages and quickly reroute power to restore power faster to customers. The technology also enables the dynamic, two-way power flow needed to support the management and growth of local distributed energy resources.

- Inception-to-date through December 31, 2021, the Self-Optimizing Grid program helped avoid approximately 182,000 extended customer outages in South Carolina, saving customers more than 550,000 hours (33.1 million minutes) of total lost outage time. It’s also paving the way for better management of local distributed energy resources by expanding line capacity and adding smart and remote switching capabilities to allow for two-way power flow.
- To date, the Companies have installed self-healing technology serving 8.7% of customers in DEC and 47.1% of customers in DEP in South Carolina. This is an increase from the 6.9% of customers served by automation in DEC and 26.9% in DEP as of December 31, 2018.

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- During 2021, the automated self-healing technologies utilized in the Self-Optimizing Grid activated at high success rates, at 100% and 97% for DEC and DEP, respectively.
- To date, the Companies have completed this work at a lower cost than originally anticipated due to less work required for substation capacity upgrades.

Distribution Transformer Retrofit – Like the SOG program, the new sectionalization capability offered by the Distribution Transformer Retrofit program minimizes the number of customers impacted by a fault or failure on the power line. These upgrades not only help to reduce customers impacted by a disruption, but also help to lower the risk of an outage occurring at the transformer itself. This program has executed as intended with more than 21,000 units installed through December 31, 2021.

Integrated Volt/VAR Control (“IVVC”) – This program will enable grid operators to operate the distribution grid in a Conservation Voltage Reduction (“CVR”) mode that would support voltage reduction and energy conservation on a year-round basis, for approximately 90% of the hours in the year. Customers are already benefiting from increased operational efficiency and improved VAR (“Volt-Amps-Reactive”) management using the controls that have been installed.

- Through December 31, 2021, the program has installed 159 (or 18%) of the capacitors, 265 (or 67%) of the regulator controls and associated load balancing efforts resulting in 116 circuits commissioned in preparation for voltage reduction. During the first 24 months, the program gained efficiencies by completing regulator control upgrades. These control upgrades provide visibility to operators about the status of voltage regulators helping them better optimize the system while additional analysis is taking place for the remaining overhead construction activities on the targeted circuits. This equipment is already providing increased operational awareness to distribution grid conditions.
- Substation IVVC construction and commissioning is ongoing with detailed engineering complete on 90 (or 90%) of the stations to date, with physical construction taking place on 25 of these stations and commissioning complete on 15 stations. Better monitoring and control capabilities are being added to station capacitor and voltage regulating equipment.
- During 2021, 3 substations and 23 distribution feeder lines served by those substations reached the IVVC construction complete status. This means the physical work inside the station fence and on the distribution lines is finished. These substations are in Anderson, Spartanburg and Greenville counties and are now available for the testing and enablement phase of IVVC.
- Software and reporting infrastructure upgrades are taking place. The project is on track to begin testing completed substations in 2022 and enabling substations to start delivering capacity and energy savings on approximately 10% of targeted substations in 2023, 20% in 2024, and 100% in 2025.

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Transmission Hardening & Resiliency – This work seeks to strengthen the grid against extreme weather and other physical threats, helping not only minimize impacts to customers, but enhance their electric service experience.

- The 44-kV System Upgrade subprogram both protects the 44-kV system from extreme weather, but also paves the way for more DER interconnections by creating additional capacity on the system to transport generation from large-scale solar sites. A key example of this work is upgrades on the Tuxedo 44-kV circuits A and B in Spartanburg County, which helps improve reliability for more than 5,000 and 3,000 customers, respectively in the county.
- The Targeted Line Rebuild for Extreme Weather subprogram upgrades vulnerable wooden structures to stronger steel structures, helping protect some higher voltage transmission lines from extreme weather.
- The Substation Flood Mitigation subprogram increases protection for substations most vulnerable to flood damage. Flood wall and gate installations at Nichols substation were completed in 2020.
- The Substation Hardening and Resiliency program includes installation of animal mitigation fencing at 5 substations, helping prevent animal-caused outages at the Peach Valley Tie, Anderson Tie, Belton Tie, Augusta Rd Retail, and Eastover Retail substations.

Transmission Bank Replacement – This work helps to predict potential transformer bank failures and conduct proactive bank replacement. These improvements help significantly reduce the impacts and costs of an unplanned replacement and help avoid outages from a catastrophic equipment failure. Waddell Road Retail transformer banks 1 and 2 were proactively replaced under this program, helping reduce the risk of a disruptive, unplanned extended outage for more than 5,000 customers.

Transmission System Intelligence – This program consists of several types of upgrades designed to enable better protection and monitoring of the transmission grid. The data collected from digital relays and condition-based monitors helps better assess and optimize transmission asset health. These projects improve reliability for customers by helping avoid unplanned outages and reducing the duration and impacts associated with transmission system interruptions. Installations of intelligent communication equipment have been completed at 28 South Carolina substations (128 Carolinas system-wide) through December 31, 2021.

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Oil Breaker Replacement – The purpose of the Oil Breaker Replacement program is to replace these legacy assets with breaker technology capable of two-way communications and remote operations to isolate a fault to the smallest section of the system to minimize customer outages. Work was accelerated to prioritize reliability and environmental improvements. Approximately 55 distribution and transmission oil breakers were replaced through December 31, 2021.

Targeted Undergrounding (“TUG”) – As of December 31, 2021, more than 26 miles of outage-prone overhead conductor have been converted to underground to improve reliability for customers experiencing a high number of historical outages, while helping restoring service more quickly and cost effectively to all customers in SC. Projects have completed for approximately 3,600 customers in 12 of the 30 South Carolina counties served by Duke Energy Carolinas and Duke Energy Progress including Chesterfield, Clarendon, Darlington, Dillon, Florence, Greenville, Lee, Marion, Spartanburg, Sumter, Williamsburg and York counties.

Long Duration Interruptions – These projects improve reliability for parts of the grid with high potential for or history of extended outages as well as for high-impact customers like airports and hospitals. Notable projects completed to date include:

- Cheraw - Pee Dee River Crossing
- Moore to Woodruff Tie
- Greenville Health System Critical Care
- Eddy Road to Panaroma Tie

Enterprise Communications – The Enterprise Communications program upgrades communication technologies, helps to secure Duke Energy’s communication network against physical and cyber threats, and provides new tools and capabilities for grid operators and field personnel. This program includes improvement and expansion of the entire communications network, from high-speed, high-capacity backbone fiber optic and microwave network improvements to upgrades to the wireless connections at the edge of the grid. These upgrades help build the secure communications required for the increasing number of smart components, sensors and remotely activated devices on the transmission and distribution systems. Through December 31, 2021, the Companies have installed or upgraded more GridWAN sites than planned as well as a considerable number of fiber miles and microwave sites that comprise parts of Duke Energy’s communication network.

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Distribution Automation – This program comprises several complementary efforts that work in concert to support dynamic and growing distribution system loads in a more sustainable way while minimizing power quality issues that often accompany a large-scale transition to DER.

- 1) The Fuse Replacement program is modernizing the grid with automatic operating devices capable of resetting themselves, resulting in fewer customer sustained and momentary service interruptions that occur at the tap or branch lines.
- 2) The Hydraulic-to-Electronic Recloser (“H2E”) project replaces end-of-service oil-filled devices with modern, remotely operated reclosing devices that support continuous system health monitoring. To date, the H2E project has executed more units for less cost.
- 3) Underground System Automation modernizes the protection and control of underground power systems that serve critical high-density areas, such as urban business districts and airports. To date, the Downtown Greenville, South Carolina Underground System Automation project has included installing vaults, duct bank infrastructure, primary circuit extensions, and fiber networks for switchgear relays for SCADA and self-healing capabilities.
- 4) The System Intelligence and Monitoring pilot will develop advanced diagnostic tools that help engineers and technicians address electrical disturbances on the distribution system and improve customer experience.

Enterprise Applications – This effort focuses on delivering advanced system planning and operational tools to improve the Company’s data analytic capabilities and help better identify future needed grid improvements. Examples of completed projects in this program include Integrated Tools of Operations Application, TUG System Software Tools, and Enterprise Distribution System Health application.

Integrated System and Operations Planning (“ISOP”) – ISOP is a comprehensive planning process using new tools to integrate generation, load, transmission, and distribution together to more effectively, efficiently, and economically deal with an increasingly diverse set of energy factors. For distribution planning, two key ISOP-related components are:

- Development of 10-year, hourly (8,760) load forecasts at the circuit level. In 2021, the Companies developed and validated hourly load forecasts for more than 4,000 distribution circuits in the Carolinas, including 900 circuits in South Carolina. These feeder-level forecasts, which include existing and projected adoption of rooftop solar, electric vehicles and customer programs, are critical inputs to the Advanced Distribution Planning (“ADP”) tools being developed.
- The ADP Toolset achieved full-scale deployment to distribution planners in the Carolinas in 2021. Development of ADP tools and processes are transforming distribution planning by introducing automation to improve efficiency of complex analytical processes needed for distribution-oriented investments. This includes automated tools for optimizing distribution

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system upgrades to accommodate customer growth (using DER-inclusive forecasts described above). When planning for system upgrades, ADP also facilitates the evaluation of battery energy storage systems as non-traditional solutions to serve those system growth needs and potentially defer distribution investments.

Physical and Cyber Security - Transmission – This program focuses on hardening physical security controls at substations to reduce the risk of external attack through subprograms including 1) Transmission Substation Physical Security, 2) Windows-based Change Outs, 3) Cyber Security Enhancements for Non-Bulk Electric System Facilities and 4) Electromagnetic Pulse and Intentional Electromagnetic Interference (EMP/IEMI) Protection. Through December 31, 2021, DEC programs have executed as anticipated. DEP contained less cyber security work than anticipated while physical security work timing was adjusted to prioritize reliability work. The Physical Security sub-program completed 20 projects across the Carolinas including Catawba, Newport Tie, Wylie, Jocassee, and Robinson substations located in South Carolina.

Physical and Cyber Security - Distribution – This program is focused on securing and improving risk mitigation on thousands of SCADA-controlled line devices (e.g. capacitors, regulators, recloser) through a combination of software and line device control upgrades.

- *Secure Access Data Management (“SADM”)* – The software “go-live” was completed during the first half of 2021, and the work of enabling the thousands of SCADA-controlled line devices is complete. The business process, change management and training efforts for the Company to maintain password and retrieve fault files securely and remotely for these devices are currently underway.
- *Distribution Line Device Protection* – DEP completed the capacitor bank control upgrades in 2020 and DEC completed the recloser control changeouts in 2021. Future work will be required to continue upgrading line device controls.

The Companies executed and completed the South Carolina GIP work to date serving our customers with a more reliable and resilient grid, plus preparing for distributed energy resources. The Companies remain committed to ensuring the benefits and costs associated with programs continue to be in alignment with expectations.